Root mapping of upland rice to access potential root extraction ratio in soil

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A better understanding of the effects of agronomic management on soil resource accessibility is needed to improve upland rice cropping systems. Here we investigated a new indicator: the potential root extraction ratio (PRER) which takes into account the overall spatial variability of root distribution in soil profiles.

Materials and methods

- Experiment conducted in Madagascar (19°33'S, 46°25'E, 945 m asl).
- Upland rice, cult. Nerica 4, grown in a rainfed experiment (cropping cycle 120 days)
- Two cropping systems: conventional tillage (CT) and no-tillage (NT)
  - CT: crop residue (maize + soybean) removed before sowing
  - NT: *Stylosanthes guianensis* residue mulch left on the soil surface.
- Gravimetric soil water measured weekly from sowing to 40 days after sowing (DAS) in 0-15 cm soil depth.
- Root distribution, shoot dry matter (SDM) and crop nitrogen (N) uptake measured at 50 DAS (three replicates).
- Root intersections (RI) counted using a grid with a 5 x 5 cm mesh, down to a depth of 80 cm over 40 cm wide soil profiles (Photo.1).
- Root length density (RLD), (Dusserre et al., 2009) and Potential Root Extraction Ratio in soil (PRER), (Nodichao et al., 2011) calculated from RI using Racine2 software (Chopart et al., 2009). PRER was calculated with two distances of N migration (MD): 1 and 2 cm.

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Photo 1: Root intersection counting (RI), trench-profile method

Results - Discussion

i) NT > CT for both crop N uptake and SDM at 50 DAS (Fig. 1).

ii) The soil water at the top-soil was better with NT due to the mulch cover (Fig. 2).

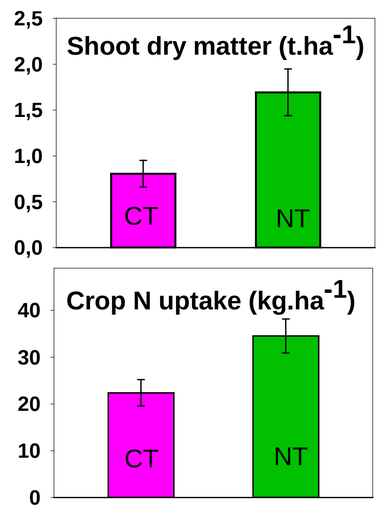

Fig. 1 Shoot dry matter and crop N uptake at 50 DAS

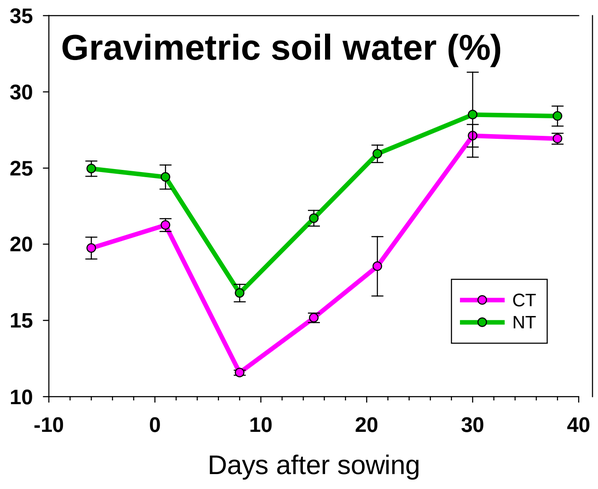

Fig. 2 Dynamic of gravimetric soil water in 0-15 cm depth

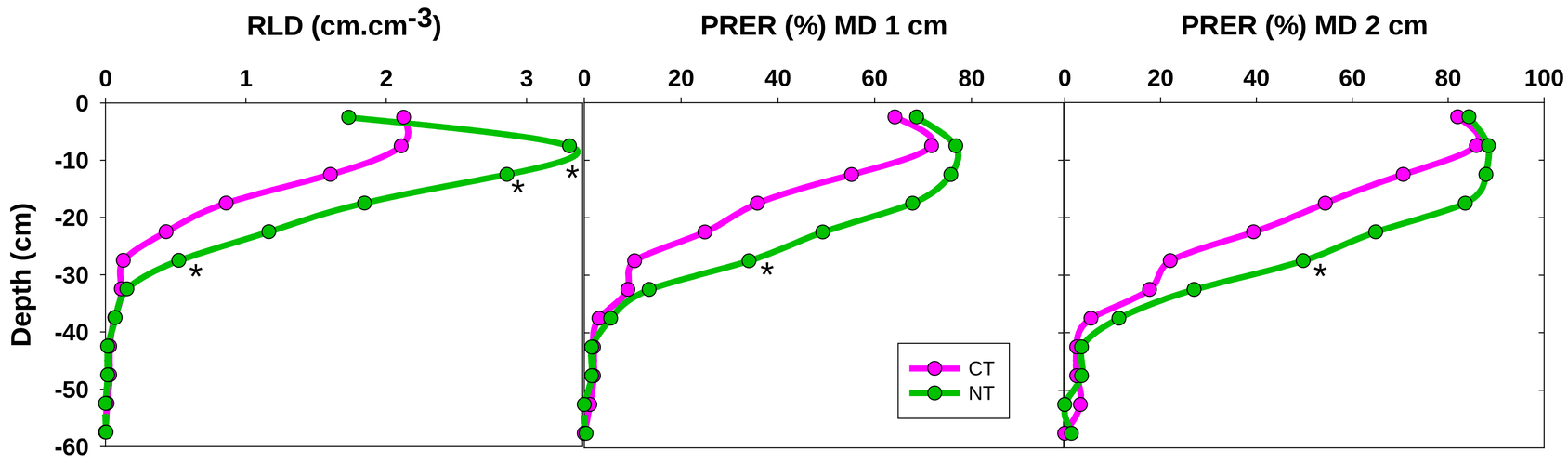

Fig. 3 Root length density and Potential root extraction ratio in soil (PRER) with 1 or 2 cm distances of N migration (MD) at 50 DAS
(*indicates significant differences)

iii) NT > CT for RLD and PRER profiles (10-30 cm depth) (Fig. 3).

iv)) If we consider a MD 2 cm rather then a MD 1 cm, the differences in PRER between the two treatments appeared less pronounced. This reflected more competition between roots (Fig. 3).

v) Even if the RLD at 10 cm with NT was high: 35 $m.dm^{-3}$ soil, it had no effect on PRER because of competition between roots (Fig. 3).

In cold conditions, plant establishment was found more difficult with NT and resulted in reduced plant development and crop N uptake (Dusserre et al., 2012).

In this experiment in warmer conditions, plant establishment was improved with NT (Fig. 1). It was probably related to the greater root development we observed, made possible by a higher water content at the top-soil (Fig. 2).

CONCLUSION

Conventional RLD values provided reliable assessment of root and plant growth.
PRER approach, using root system distribution, gave an estimation of potential available nutrient in the soil.
PRER could be used as another reliable indicator of crop functioning under nutrient deficiency conditions.

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